REMARKS

Claims 7-8, 15, 22, and 27 have been amended. Claims 1-2, 4-15, and 17-36 are pending, with claims 1, 7-8, 15, 22, and 27 being independent.

Attached hereto is an Appendix entitled "Version with Markings to Show Changes Made" which is a marked-up version of the portions of the application which have been amended by the present amendment, with brackets indicating deleted matter and underlining indicating added matter.

On page 1 (the Office Action Summary) of the Office Action of May 13, 2002, the Examiner has indicated that claims 1-2, <u>7</u>-15, and 17-36 are pending and are rejected, apparently as a result of inadvertent errors in the first paragraph on page 14 of the amendment of March 11, 2002, where it was inadvertently incorrectly indicated that claims 1-2, <u>7</u>-15, and 17-36 had been amended and were pending. However, claims 1-2, <u>4</u>-15, and 17-36 were actually amended in the amendment of March 11, 2002, and claims 1-2, <u>4</u>-15, and 17-36 are pending.

Furthermore, the Examiner has set forth rejections of claims 4-6 on pages 9, 11, and 15 of the Office Action of May 13, 2002, such that page 1 (the Office Action Summary) of the Office Action of May 13, 2002, should have indicated that claims 1-2, <u>4</u>-15, and 17-36 are pending and are rejected.

Independent claims 7-8, 15, 22, and 27 have been amended to more clearly define the present invention by reciting a feature of the present invention <u>which is already recited in independent claim 1 and has already been considered by the Examiner</u>, i.e. the feature of claim 1 wherein the local gradation

conversion is performed <u>to locally match a brightness of the first image with a brightness of the second image</u>. Since this feature which has been added to independent claims 7-8, 15, 22, and 27 <u>has already been considered by the Examiner in independent claim 1</u>, it is submitted that the amendment of independent claims 7-8, 15, 22, and 27 in the present amendment after final rejection to include this feature does <u>not</u> raise new issues that would require further search and/or consideration, such that entry of this amendment after final rejection is <u>proper</u> under 37 CFR 1.116 and MPEP 714.12 and 714.13.

Claims 1, 4, 8-14, and 22-26 were rejected under 35 USC 103(a) as being unpatentable over Lee et al. (Lee) (U.S. Patent No. 5,808,735) in view of Danielson et al. (Danielson) (U..S. Patent No. 4,926,489).

Claims 31, 33, and 35 were rejected under 35 USC 103(a) as being unpatentable over Lee in view of Danielson and Teo (U.S. Patent No. 6,128,108).

Claims 1, 5, 7, 15, 21, and 27-29 were rejected under 35 USC 103(a) as being unpatentable over Lebeau in view of Kobayashi et al. (Kobayashi) (U.S. Patent No. 4,669,123), and Danielson.

Claims 6, 19, and 30 were rejected under 35 USC 103(a) as being unpatentable over Lebeau in view of Kobayashi, Danielson, and Wagner et al. (Wagner) (U.S. Patent No. 5,659,172).

Claims 2 and 17 were rejected under 35 USC 103(a) as being unpatentable over Lebeau in view of Kobayashi, Danielson, and Haskell et al. (Haskell) (U.S. Patent No. 6,111,596).

Claims 32, 34, and 36 were rejected under 35 USC 103(a) as being unpatentable over Lebeau in view of Kobayashi, Danielson, and Teo.

Claims 15, 18, and 20 were rejected under 35 USC 103(a) as being unpatentable over Wihl (U.S. Patent No. 4,633,504) in view of Danielson.

The rejections of claims 1-2, 4-6, and 31 are respectfully traversed, and the rejections of claims 7-15, 17-30, and 32-36 are respectfully traversed insofar as they may be deemed to be applicable to claims 7-15, 17-30, and 32-36 in their present form.

Independent claim 1 which has not been amended by the present amendment recites, inter alia, performing local gradation conversion of at least one of the stored first image and the second image to locally match a brightness of the first image with a brightness of the second image.

The Examiner considers this feature of claim 1 to be taught by Lee, stating as follows in pertinent part in the Office Action of May 13, 2002:

> Regarding the gradation conversion to locally match a brightness, Lee teaches this feature as explained in the rejection below, and as explained in paragraph 9 of the previous Office Action. That is, Lee teaches that the intensity values of each pixel are corrected in order that the images correspond in brightness to one-another (i.e., "test and reference images differ slightly in intensity" and the "system 20 compensates for these normal intensity differences (step 220) by providing an intensity offset" at column 6, line 15; "offsetting the intensity values of each reference pixel" at column 6, line 32). While applicant alleges that Lee does not teach a gradation conversion to match brightness, no evidence is provided as to how Lee's pixel vale conversion, or offsetting of pixel values so that the images correspond with one another does not meet the claimed criteria. Examiner maintains that the conversion of pixel values, as

disclosed by Lee, meets the criteria of a gradation conversion.

. . . .

. . . Regarding independent claims 1, 8 and 22 as amended, Lee discloses local gradation conversion means for performing local gradation conversion to correct a brightness, and thereby match the brightness of one image to that of the other (i.e., "test and reference images differ slightly in intensity" and the "system 20 compensates for these normal intensity differences (step 220) by providing an intensity offset" at column 6, line 15; figure 2A, numeral 220; "normalized for intensity" at column 6, line 42; as described at column 6, lines 30-33, the intensity values of the images are made to correspond more closely with one-another, or corrected with respect to one-another, based on a histogram of differences).

The image-intensity normalization between test and references images in step 220 in Fig. 2A of Lee referred to by the Examiner is described, for example, in column 6, lines 13-33, of Lee which reads as follows:

Images of defect-free areas of the test surface should be very similar to images of corresponding areas of the reference surface. In practice, however, test and reference images differ slightly in intensity even in the absence of defects due to imaging and process variations. ADC system 20 compensates for these normal intensity differences (step 220) by providing an intensity offset I_{OFF} so that they do not result in the erroneous detection of defects.

The test and reference images are aligned and their relative intensities are compared pixel-by-pixel. The x-y locations of any test and reference pixel pair P_T, P_R having intensity values I_{MAX} that differ by an amount exceeding the intensity-error threshold I_{TH} assigned to the x-y location are identified as potential defect pixels. The intensity differences of the remaining pixels are then used to create an intensity histogram. The peak value of the intensity histogram represents the most common intensity difference between test

> and reference pixel pairs P_T, P_R. In step 220 ADC system 20 compensates for normal intensity differences by offsetting the intensity values of each reference pixel $P_R(I_{max})$ by the peak value of the intensity histogram.

Thus, as can be seen from this passage, Lee teaches offsetting the intensity value of each of the reference pixels in the reference image by the same value, i.e. by the peak value of the intensity histogram. It is submitted that this is a global gradation conversion which globally matches a brightness of Lee's reference image with a brightness of Lee's test image, rather than a local gradation conversion which locally matches a brightness of Lee's reference image with a brightness of Lee's test image as would be required to provide the feature of performing local gradation conversion of at least one of the stored first image and the second image to locally match a brightness of the first image with a brightness of the second image recited in claim 1.

It is submitted that Lee's method matches an overall brightness of Lee's entire reference image with an overall brightness of Lee's entire test image, whereas the present invention as recited in claim 1 matches local brightnesses of local areas of the stored first image with local brightnesses of local areas of the second image.

Accordingly, for the reasons discussed above, it is submitted that Lee does not disclose or suggest performing local gradation conversion of at least one of the stored first image and the second image to locally match a brightness of the first image with a brightness of the second image as recited in claim 1 as alleged by the Examiner.

The Examiner also considers the feature <u>performing local gradation conversion of at least one of the stored first image and the second image to locally match a brightness of the first image with a brightness of the second image</u> recited in claim 1 to be taught by Lebeau, stating as follows in pertinent part in the Office Action of May 13, 2002:

> Regarding the gradation conversion to locally match a brightness, Lebeau teaches this feature as explained in the rejection below, and as explained in paragraph 11 of the previous Office Action. That is, Lebeau teaches that the intensity values of each pixel are corrected in order that the images correspond in brightness to one-another (i.e., the graylevels of the "[r]un image ... are then mapped based on a comparison of the mean brightness of the taught image to that of the run image" so "the mean brightness level ... is the same as the mean value of taught image" at column 5, lines 50-54). While applicant alleges that Lebeau does not teach a gradation conversion to match brightness, no evidence is provided as to how Lebeau's pixel vale mapping (so that the images correspond with one another) does not meet the claimed criteria. Examiner maintains that the conversion of pixel values, as disclosed by Lebeau, meets the criteria of a gradation conversion to match brightness.
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> . . . .
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> . . . Regarding independent claims 1, 7, 8, 15 and 27 as amended, Lebeau discloses local gradation conversion means for performing local gradation conversion to match a brightness of one image to that of the other (i.e., the graylevels of the "[r]un image ... are then mapped based on a comparison of the mean brightness of the taught image to that of the run image" so "the mean brightness level ... is the same as the mean value of taught image" at column 5, lines 50-54).

Column 5, lines 50-54, of Lebeau referred to by the Examiner is part of the longer passage in column 5, lines 30-54, of Lebeau which reads as follows:

> FIG. 6 shows the image slice represented in FIG. 1 with a plurality of brightness levels. A taught image slice of average brightness is represented by a graph of a plurality of graylevels 37, which are similar to graylevels 15 (FIG. 1). For explanatory purposes both a light run image and a dark run image are described even though only a single run image is typically used for each inspection. A relatively bright run image slice is represented by a graph of a plurality of graylevels 38. A relatively dark run image slice is represented by a graph of a plurality of graylevels 39. Mapping of the representation of the image brightness to remove this variation of brightness requires that the mean brightness level of both the taught image and the run image be determined. Graylevels 38 and 39 are then mapped by a linear scaling so the mean brightness level of both is the same as the mean value of taught image slice graylevels 37. A linear scaling of graylevel values serves to adjust the graylevel values which differ from the mean in proportion to their brightness levels. The preferred embodiment of this invention uses a graylevel histogram analysis to determine the mean brightness levels of the run image. Run image slice graylevels 38 and 39 are then mapped based on a comparison of the mean brightness of the taught image to that of the run image.

As can be seen from this passage of Lebeau and Fig. 6 of Lebeau referred to in this passage of Lebeau, Lebeau teaches making the <u>mean</u> brightness of graylevels 38 representing a relatively bright run image slice or the <u>mean</u> brightness of graylevels 39 representing a relatively dark run image slice match a <u>mean</u> brightness of graylevels 37 representing a taught image slice of average brightness. It is submitted that this is a <u>global</u> gradation conversion which <u>globally</u> matches a brightness of Lebeau's run image slice with a brightness of Lebeau's taught image slice, rather than a <u>local</u> gradation conversion which <u>locally</u> matches a brightness of Lebeau's run image slice with a brightness of Lebeau's taught image slice as would be required to provide the feature of

performing local gradation conversion of at least one of the stored first image and the second image to locally match a brightness of the first image with a brightness of the second image recited in claim 1.

It is submitted that Lebeau's method matches an overall brightness of Lebeau's entire run image slice with an overall brightness of Lebeau's entire taught image slice, whereas the present invention as recited in claim 1 matches local brightnesses of local areas of the stored first image with local brightnesses of local areas of the second image.

Accordingly, for the reasons discussed above, it is submitted that Lebeau does not disclose or suggest performing local gradation conversion of at least one of the stored first image and the second image to locally match a brightness of the first image with a brightness of the second image as recited in claim 1 as alleged by the Examiner.

Furthermore, it is submitted that Danielson, Teo, Kobayashi, Wagner, Haskell, and Wihl do not disclose or suggest the feature performing local gradation conversion of at least one of the stored first image and the second image to locally match a brightness of the first image with a brightness of the second image recited in claim 1.

Independent claim 7 now recites, inter alia, performing local gradation conversion of at least one of the stored first image and the second image to locally match a brightness of the stored first image with a brightness of the second image and aligning the stored first image and the second image with an

accuracy of one pixel unit, and then comparing the first and second images to detect a defect and to obtain features of the detected defect.

Independent claim 8 now recites, inter alia, comparing a first image produced by picking up a first pattern formed on a substrate and a second image produced by picking up a second pattern that is formed on the substrate so as to have naturally the same shape as the first pattern after at least one of the first image and the second image has been subjected to local gradation conversion to locally match a brightness of the first image with a brightness of the second image and the first image and the second image have been aligned with an accuracy of one pixel unit, thereby extracting defects to be proposed, and obtaining certainty information of the extracted proposed defects.

Independent claim 15 now recites, inter alia, local gradation conversion means for performing local gradation conversion of at least one of the stored first image and the second image to locally match a brightness of the stored first image with a brightness of the second image.

Independent claim 22 now recites, inter alia, proposed-defects extracting means for processing the images of the patterns when the substrate placed on the table means is continuously moved after at least one of the images of the patterns has been subjected to local gradation conversion to locally match a brightness of the at least one of the images with a brightness of at least one other one of the images and the images of the patterns have been aligned with an accuracy of one pixel unit, thereby extracting proposed defects of the patterns.

Independent claim 27 now recites, inter alia, defect detection means for correcting at least one of the stored first image and the second image by at least performing local gradation conversion of at least one of the stored first image and the second image to locally match a brightness of the stored first image with a brightness of the second image and aligning the stored first image and the second image with an accuracy of one pixel unit, comparing the first image and the second image to detect defects after the at least one of the stored first image and the second image has been corrected, and then estimating information of the detected defects.

It is submitted that Lee and Lebeau do not disclose or suggest the features of claims 7-8, 15, 22, and 27 which are underlined above for at least substantially the same reasons discussed above that Lee and Lebeau do not disclose or suggest the similar feature of claim 1.

Dependent claim 31 recites a method according to claim 1, wherein the local gradation conversion minimizes a sum of squares of differences between the brightness of the first image and the brightness of the second image within each of a plurality of local areas of the first image and the second image.

The Examiner considers this feature of claim 31 to be taught by Teo, stating as follows in the Office Action of May 13, 2002:

> Teo discloses a system in the same field of image processing (i.e., "the present invention relates to digital image processing" at column 1, line 5), and same problem solving area of normalizing two images, or matching the brightness of two images ("variation due to different lighting conditions is reduced" at column 2, line 64; images A and B "which were taken under different lighting conditions" at column 8, line

67; "bring the two images into line with one another. Specifically, brightness, contrast and gamma parameters ... are used to modify image color intensity" at column 9, line 7), comprising a local gradation conversion ("once the brightness, contrast and gamma parameters are determined, they are applied to image A" at column 10, line 27; it can be seen from equation 9 that the parameters are applied to each and every pixel as designated by "x,y" and thus the brightness conversion is local, or takes place in local areas) that minimizes a sum of squares of differences between the brightness of the first and second images ("seeks to match as best possible the color intensities of image A using a least sum of squares error criterion ... it seeks to minimize the deviation between the color intensities" at column 9, line 23; see equations 3).

However, as described, for example, in column 10, lines 27-34, of Teo, a single brightness parameter α calculated for an entire image is applied to each of the pixels of the entire image to adjust the brightness of the image. Thus, as can be seen from this passage of Teo, Teo teaches adjusting the brightness of each of the pixels of an entire image by the same value, i.e. by the brightness parameter α. It is submitted that this is a global gradation conversion which globally matches a brightness of one of Teo's images A and B with a brightness of the other one of Teo's images A and B, rather than a local gradation conversion which locally matches a brightness of one of Teo's images A and B with a brightness of the other one of Teo's images A and B as would be required to provide the feature wherein the local gradation conversion minimizes a sum of squares of differences between the brightness of the first image and the brightness of the second image within each of a plurality of local areas of the first image and the second image recited in claim 31.

It is submitted that Teo's method matches an overall brightness of one of Teo's images A and B with an overall brightness of the other one of Teo's images A and B, whereas the present invention as recited in claim 1 matches local brightnesses of local areas of the stored first image with local brightnesses of local areas of the second image.

Accordingly, for the reasons discussed above, it is submitted that Teo does not disclose or suggest the feature of claim 31 wherein the local gradation conversion minimizes a sum of squares of differences between the brightness of the first image and the brightness of the second image within each of a plurality of local areas of the first image and the second image as alleged by the Examiner.

Furthermore, it is submitted that Lee, Danielson, Lebeau, Kobayashi, Wagner, Haskell, and Wihl do not disclose or suggest the feature of claim 31 wherein the local gradation conversion minimizes a sum of squares of differences between the brightness of the first image and the brightness of the second image within each of a plurality of local areas of the first image and the second image.

Dependent claim 32 recites a method according to claim 7, wherein the local gradation conversion minimizes a sum of squares of differences between a brightness of the first image and a brightness of the second image within each of a plurality of local areas of the first image and the second image.

Dependent claim 33 recites a method according to claim 8, wherein the local gradation conversion minimizes a sum of squares of differences between a

brightness of the first image and a brightness of the second image within each of a plurality of local areas of the first image and the second image.

Dependent claim 34 recites an apparatus according to claim 15, wherein the local gradation conversion minimizes a sum of squares of differences between a brightness of the first image and a brightness of the second image within each of a plurality of local areas of the first image and the second image.

Dependent claim 35 recites an apparatus according to claim 22, wherein the local gradation conversion minimizes a sum of squares of differences between a brightness of one of the images of the patterns stored in the storage means and a brightness of one of the images of the patterns produced by the image pick-up means within each of a plurality of local areas of the one of the images of the patterns stored in the storage means and the one of the images of the patterns produced by the image pick-up means.

Dependent claim 36 recites an apparatus according to claim 27, wherein the local gradation conversion minimizes a sum of squares of differences between a brightness of the first image and a brightness of the second image within each of a plurality of local areas of the first image and the second image.

It is submitted that Teo does not disclose or suggest the features of claims 32-36 which are underlined above for at least substantially the same reasons discussed above that Teo does not disclose or suggest the similar feature of claim 31.

Since Lee, Danielson, Teo, Lebeau, Kobayashi, Wagner, Haskell, and Wihl do not disclose or suggest the features of claims 1, 7-8, 15, 22, 27, and 31-36

discussed above, it is submitted that claims 1, 7-8, 15, 22, 27, and 31-36 and claims 2, 4-7, 9-14, 17-21, 23-26, and 28-30 depending from claims 1, 8, 15, 22, and 27 patentably distinguish over Lee, Danielson, Teo, Lebeau, Kobayashi, Wagner, Haskell, and Wihl in the sense of 35 USC 103(a), and it is respectfully requested that the rejections of claims 1-2, 4-15, and 17-36 under 35 USC 103(a) as being unpatentable over Lee, Danielson, Teo, Lebeau, Kobayashi, Wagner, Haskell, and Wihl be withdrawn.

Although dependent claims 2, 4-7, 9-14, 17-21, 23-26, and 28-30 are considered to be allowable by virtue of their dependency from allowable claims 1, 8, 15, 22, and 27, it is noted that these dependent claims also recite further features of the present invention which are not seen to be disclosed or suggested by the prior art.

It is submitted that all of the Examiner's rejections have been overcome, and that the application is now in condition for allowance. Entry of this amendment, reconsideration of the application, and an action of a favorable nature are respectfully requested.

To the extent necessary, the applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, or credit any

overpayment of fees, to the deposit account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (500.37149X00).

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP

Paul J. Korniczky Reg No 32,193 for

Melvin Kraus
Registration No. 22,466

MK/RSS
(703) 312-6600

Attachment

APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

Changes made to the application by the present amendment are indicated below, with brackets indicating deleted matter and underlining indicating added matter.

IN THE CLAIMS

Claims 7-8, 15, 22, and 27 have been amended as follows:

--7. (Twice Amended) A method of inspecting a pattern, comprising the steps of:

picking up a first pattern formed on a substrate to produce a first image;

storing the first image;

picking up a second pattern that is formed on the substrate so as to have naturally the same shape as the first pattern, thereby producing a second image;

performing local gradation conversion of at least one of the stored first image and the second image <u>to locally match a brightness of the stored first image with a brightness of the second image</u> and aligning the stored first image and the second image with an accuracy of one pixel unit, and then comparing

the first and second images to detect a defect and to obtain features of the detected defect; and

displaying information of the features of the detected defect on a screen.

8. (Twice Amended) A method of inspecting a pattern, comprising the steps of:

comparing a first image produced by picking up a first pattern formed on a substrate and a second image produced by picking up a second pattern that is formed on the substrate so as to have naturally the same shape as the first pattern after at least one of the first image and the second image has been subjected to local gradation conversion to locally match a brightness of the first image with a brightness of the second image and the first image and the second image have been aligned with an accuracy of one pixel unit, thereby extracting defects to be proposed, and obtaining certainty information of the extracted proposed defects;

detecting a true defect from the extracted proposed defects; and

producing information of the detected true defect.--

--15. (Twice Amended) An apparatus for inspecting defects of patterns, comprising:

image pick-up means for picking up a first pattern formed on a substrate and a second pattern that is also formed on the substrate so as to

have naturally the same shape as the first pattern, thereby producing a first image of the first pattern and a second image of the second pattern;

storage means for storing the first image;

alignment means for aligning the stored first image and the second image with an accuracy of one pixel unit;

local gradation conversion means for performing local gradation conversion [to correct a brightness] of at least one of the stored first image and the second image <u>to locally match a brightness of the stored first image with a brightness of the second image;</u>

defect detection means for comparing the aligned first and second images, at least one of which has a brightness which has been corrected by the local gradation conversion means, thereby detecting defects of the patterns; and

output means for producing information of the defects of the patterns detected by the defect detection means.--

--22. (Twice Amended) An apparatus for inspecting defects of a plurality of patterns formed on a substrate so as to have naturally the same shape, comprising:

table means on which the substrate is placed, and which can be moved in an X-Y plane;

image pick-up means for picking up the patterns of the substrate placed on the table means to produce images of the patterns;

proposed-defects extracting means for processing the images of the patterns when the substrate placed on the table means is continuously moved after at least one of the images of the patterns has been subjected to local gradation conversion <u>to locally match a brightness of the at least one of the images with a brightness of at least one other one of the images</u> and the images of the patterns have been aligned with an accuracy of one pixel unit, thereby extracting proposed defects of the patterns;

defect detection means for detecting true defects from the proposed defects of the patterns that have been extracted by the proposed-defects extraction means; and

output means for producing information of the true defects detected by the defect detection means.--

--27. (Twice Amended) An apparatus for inspecting defects of patterns, comprising:

image pick-up means for picking up a first pattern formed on a substrate and a second pattern that is formed on the substrate so as to have naturally the same shape as the first pattern, thereby producing a first image of the first pattern and a second image of the second pattern;

storage means for storing the first image;

defect detection means for correcting at least one of the stored first image and the second image by at least performing local gradation conversion of at least one of the stored first image and the second image <u>to</u>

locally match a brightness of the stored first image with a brightness of the second image and aligning the stored first image and the second image with an accuracy of one pixel unit, comparing the first image and the second image to detect defects after the at least one of the stored first image and the second image has been corrected, and then estimating information of the detected defects; and

display means for displaying on a screen the defects detected by the defect detection means, and the information of the detected defects.--